SCIENCE

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CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*INAUGURAL ADDRESS OF THE PRESIDENT OF THE STEVENS INSTITUTE OF TECHNOLOGY.**

IN subscribing to this oath of office I am profoundly sensible of the responsibilities I assume.

For the two months preceding my acceptance of the presidency of Stevens Institute I was constantly studying the many questions involved therein, and especially that of my fitness for the office. I feared that it would be presumptuous for a man not an educator by profession to undertake to carry on Dr. Morton's great work; at the best it seemed to me an experiment of doubtful wisdom, for failure meant probable injury to the loved *alma mater* as the return for serious sacrifices to be made by myself and those dear to me.

In considering the objection that I had not been trained as an educator, I was not unmindful, on the other hand, of the fact that in my professional career I had been called to direct the later studies of graduates of engineering schools, including a large number of Stevens men, and so had been forced to study and appraise from the viewpoint of practice, the efficiency of the training supplied by a number of our technical schools. In this work I had found myself deeply interested; and in reviewing my experiences in this and some other di-

* Delivered in the Carnegie Laboratory of Engineering, February 5, 1903.

rections in which I had been brought into practical contact with educational work, I was encouraged to hope that if I accepted this office my lack of training and experience in the school might in part be compensated for by these experiences and my sympathy with the aspirations of youth.

Finally my action was determined by the fact that the call was made by the trustees, faculty, alumni association and many of the alumni individually.

Since I have been in daily contact with the duties and responsibilities of the office I have been more and more impressed with the largeness of my undertaking and with the practically unlimited opportunities afforded for the exercise of a wise, patient, firm and energetic leadership.

As all this and more is included in my view of the situation, necessarily then I am profoundly sensible of my new responsibilities. But I must ask those at whose instance I have accepted this office to understand that they have not shifted their responsibilities to my shoulders. I shall look to them to help me to carry my new burdens and to be patient with me when I hesitate or stumble on the way.

As the circumstances under which I have accepted office are somewhat unusual, I have, at the risk of being misunderstood, decided to thus briefly refer to some of the influences under which I have acted.

The responsibility rests upon us all—trustees, faculty and alumni—to preserve and further extend and perfect that which has been so well built on the noble benefaction of E. A. Stevens. The admirable record which has been made during the thirty years of Dr. Morton's brilliant, wise and self-sacrificing administration will not alone carry the institute over the obstacles surely to be met in the years to come.

This reference to the work of our honored late president leads me to recall with a reverent sense of appreciation the devoted services of Professors Wood, Mayer and Leeds, who are with him now resting from their labors.

While resolving to zealously preserve and develop that which has been passed on for a while to our stewardship, let us consider whether this calls for any departure from the established ways. My four months' experience as acting president, added to that gained as alumnus, trustee, engineer and man of business, leads me to say emphatically that though there is much to be done, there is no change in principle or policy to be desired or tolerated.

The changes to be made are chiefly those called for by the increase in the number of students. A glance at the register shows that the equipment, methods and administration of twenty years ago are no longer adequate to meet our present requirements. Even with his own repeated benefactions Dr. Morton was unable to keep pace with the requirements as they developed.

The first ten classes graduated numbered as follows:

'73, 1; '74, 3; '75, 10; '76, 17; '77, 10; '78, 22; '79, 14; '80, 9; '81, 17; '82, 14. Total for first ten years, 117.

The last ten classes graduated numbered as follows:

'93, 43; '94, 39; '95, 45; '96, 64; '97, 63; '98, 57; '99, 53; 1900, 53; 1901, 40; 1902, 54. Total for last ten years, 511.

There have been 987 graduated up to date, of whom 54 have passed on to that other life where their records as engineers are only of moment as affecting their records as men.

These figures alone do not furnish a fair comparison and should be supplemented by a comparison of enrollments.

The enrollment at the end of the first ten-years period was:

Freshmen	53
Sophomores	47

Juniors	20
Seniors	12
Total	132

and the enrollment at the end of the last ten-years period was:

Freshmen	87
Sophomores	78
Juniors	48
Seniors	55
Total	268

The enrollment at the beginning of this school year was:

Freshmen	115
Sophomores	69
Juniors	62
Seniors	50
Total	296

Though by these last comparisons it appears that we have only something more than double the number of students to care for than we had twenty years ago, the practical facts are that in our upper classes we have nearly five times as many to instruct; and, as most of our class- and lecture-rooms can accommodate only about fifty students, the lower classes have to be taught in sections, requiring the professors and instructors to duplicate much of their work.

This all means that we need larger class- and lecture-rooms, larger chemical and physical laboratories and shops, a general auditorium, additional equipment and additional instructors.

Another addition, which should be made, is at least one dormitory.

To complete our course in four years requires of the students hard work and long hours. It is thus incumbent on us to do our utmost to keep the students in good working condition, mentally and physically.

To this end they should have cheerful, comfortable, sanitary, though simple, lodgings, and plain, wholesome and attractive food. Men so cared for and provided with facilities for intelligent recreation should be able to safely undertake a large amount of work, and should be less liable to seek relaxation in harmful pleasures.

I am most anxious to promptly secure such an addition to our plant as will enable us to offer these more attractive and elevating surroundings to those of our students who in coming to us are cut off from home influences.

This would add to the cares and responsibilities of the administrative officers, but it would also give us additional opportunities to influence the students for good.

It would also tend to cultivate a healthier college spirit and to attract more men from the several sections of the country, which would in itself be broadening and mellowing to the student body.

On the basis of the present fees for instruction the original Stevens endowment was at first ample to furnish the additional income required to meet the difference between the yearly expenses and the income from students. That difference now amounts to about $100 per year per student. The original endowment would now be entirely inadequate to meet our developed requirements, and even with the additions made by Dr. Morton from time to time, aggregating $150,000, the Carnegie Laboratory and its special endowment of $100,000, $30,000 given at the time of our twenty-fifth anniversary by Mrs. E. A. Stevens, Sr., and other additions by members of the Stevens family, our endowment is insufficient to meet present needs, to say nothing of the additions required to be made to our plant and our teaching staff as already outlined. Expenditures which the trustees, upon my earnest recommendation, have already authorized lead me to fear a deficit at the end of this school year. Against this it is encouraging to note that provision is already being made to meet some of the deficiencies in our plant.

Before Dr. Morton's death $60,000 had been subscribed by him and the alumni for a laboratory of chemistry. This amount proves under present market conditions insufficient for the purpose, and I am now applying to the alumni—and the alumni alone—for an additional $60,000 to enable us to build and thoroughly equip a laboratory which will equal, if not surpass, in practical efficiency anything of the kind in the world. This is a large additional sum to ask from such a small body of men, the majority of whom are young and working on salaries; but if we succeed—as I believe we shall—this addition is to be named the Morton Laboratory of Chemistry, and it will serve as a most fitting memorial of our late president.

In moving into the Carnegie Laboratory of Engineering we set free the ground floor of the main building. At comparatively small expense this can be arranged to afford an excellent location for larger and more efficient shops. Moving the shops from their present location would set free the old auditorium, which with certain changes and additions could be restored to its original purpose and provide for an audience of seven hundred. This change, including some additional tools and certain other minor, but much-needed, additions to our plant, could be effected for a cost not to exceed $25,000; part of this has been subscribed contingent upon the whole sum being pledged.

One important step has been taken towards the beginning of dormitory life. Col. E. A. Stevens, our trustee, and his brother Robert L., sons of our founder, have notified me that a piece of land, 200 x 100 feet, which they jointly own in the block adjoining the institute's property, admirably located for the purpose, will be deeded to the Institute provided we can promptly erect thereon a dormitory. Preliminary plans have been drawn for a group of three buildings, which can be erected separately or together, as circumstances demand or warrant. One of these buildings would contain a refectory to cater to all the students lodged in the three buildings. Each unit in this group could be well made to serve as a separate memorial and named accordingly. I believe the cost of one of these units could be quickly pledged if pledges for the other two could be obtained. The entire group would accommodate about 110 students, and would be sufficient for our present needs.

This would not only greatly increase the efficiency of our plant, but would considerably add to our income.

What I have said will serve to correct the opinion held by many that our endowment is sufficient for our needs. There are some who know more or less completely of those needs, but hold, as I believe, a totally unwarranted opinion as to where we should look for relief. After considering the question long and carefully, I have decided to openly combat this opinion: namely, that as the institute carries the name of Stevens, the heirs of E. A. Stevens should be responsible for its support. This strikes me as a most unjust proposition.

E. A. Stevens bequeathed $650,000 and a block of land for an institution of learning. So well has this trust been administered that a new line of educational work has been developed, and the success achieved has created the demand for the increased facilities I have just mentioned.

Because the world has secured through the original endowment so much more than could have been reasonably anticipated, does that furnish a reason for demanding from the heirs of our founder, after the balance of his fortune has been divided into many parts, that they keep pace with this

constantly increasing financial requirement by constant additions to our endowment?

Rather, it seems to me, that because of the great work accomplished primarily through the instrumentality of the Stevens endowment, the community and those who have directly and indirectly profited by the advances made in technical education during the last thirty years—and it would be hard to find in the United States those who have not so profited—owe it to E. A. Stevens, his heirs, Dr. Morton and those who as trustees and instructors have faithfully worked with him, to provide the means to maintain, extend and perfect that which is already a powerful agency for good.

I have gone so far in speaking on a somewhat delicate subject, I may as well go farther in the hope of disposing of this question once for all.

It has been further suggested, that as the institute carries a family name, we have but little chance of securing aid from sources outside of that family. I do not doubt that this may influence some narrow-minded men against coming to our relief. But we can show against this that it has not stayed the helping hands of Henry Morton and Andrew Carnegie.

The evidences are on every side that our rich men are exercising more intelligent discrimination in the effort to secure full returns on their philanthropic investments. As with their personal investments, they are coming to investigate in advance, to make as sure as possible that their benefactions will secure full returns in perpetuity. To such a man it could be readily shown that a million dollars added to our present endowment and plant, would give a far greater return than could possibly be derived from the same amount employed to establish a new institution.

And now why should not the name of 'Stevens' be attached to our institution? Our original endowment was a large one for the time when it was made, and it was most natural that the institute should have been named after our founder, though it is a fact that some of the family opposed that course. I can say that, while in my opinion any change would be most unwise, the Stevens family would be the first to urge a change if they believed that a majority of the alumni were in favor of it, or if by so doing we could secure the cooperation which would enable us to enlarge our usefulness. But it can not be supposed that the alumni would be willing to surrender the prestige which is theirs through being known as graduates of Stevens.

If we must consider the question of name, it should be seen that we offer an advantage rather than otherwise. Such an addition to our endowment as I have spoken of would be naturally individualized under the name of the donor. That name would not be alone, but would stand with the three great names—Stevens, Carnegie, Morton—and this should attract rather than repel.

In estimating our future requirements we should not fail to recognize that there has been within the last few years a marked increase in the demand for technically educated men. It is beginning to be recognized that the commanding position which the United States to-day holds in the fields of industry and commerce, is in considerable measure due to the intelligent and conscientious work done during the last thirty years by our technical schools.

While our country has benefited by a unique combination of natural advantages, it needed the men technically educated, working in an atmosphere most favorable to the full utilization of their best powers, to secure from these conditions the exceptional prosperity of to-day.

We can better appreciate our advantages, both as to superiority in the line of

technical education and freedom from the trammels of caste, when we compare our condition in these regards with that of Great Britain; yes, and even with that of Germany.

This increase in the demand for scientifically trained engineers is evidenced by the fact that whereas thirty, and even ten, years ago employers could select from the graduating classes to meet their requirements, to-day many concerns now accept these graduates and apply for them a year in advance, without being able to exercise any such selection. This has resulted in creating some question in the minds of certain employers as to whether our methods are now as efficient as in the past. Naturally they find that the cadet engineers they now hire without the advantages of selection do not average as high as those engaged in years gone by.

This does not at all mean that every young man must succeed because he is a graduate of Stevens or some other good engineering school. It only means that his diploma will give him the opportunity to prove the stuff of which he is made.

Since Stevens Institute was opened many new engineering schools have been organized, and the departments of applied science in many of our universities have been so developed and improved that they have in some cases become the very life of the universities with which they are connected.

As we contemplate this change we may be tempted to question whether our little school has a work to perform which can not be safely left to others. Then let us remember how many there are in this vast and growing country requiring, for the nation's good, to be educated in applied science. In thirty years Stevens has placed less than one thousand men in the industrial ranks. There is room and more than room for all of these schools, and we may well wish them all Godspeed.

If some time in the future it were found that there were more than enough technical schools to supply the wants of this great country, the country should be the gainer, for the fittest only would survive. And if under this searching test it were found that we were unable to show a reason for our continued existence, we could at least take comfort from the reflection that we had helped in no mean degree to make possible the progress in educational methods with which we had finally been unable to keep pace.

But I prefer to believe that, let the standard be developed never so high, Stevens will be found steadily in the van.

In the past there has been a tendency in our technical schools to specialize too closely. Graduates of technical schools are sometimes to be heard regretting that they had not first taken a B.A. course. Part of this is no doubt a well-grounded regret occasioned by a too narrow training, but part of it is the natural inclination we all experience to long for that we do not possess, and lightly regard that we have grown familiar with through years of use. No doubt every possible effort should be made to include in the engineer-student's curriculum all that the four years will safely contain of such non-technical studies as will be best qualified to make the course broad as a whole. But let us be careful that the reaction from the fault of too close specialization does not carry us to the other extreme.

First our students should be thoroughly and completely trained in the fundamentals required in the practice of their profession. They must be given a *working* knowledge of the higher mathematics and an accurate knowledge of the fundamental laws of nature; and throughout the course they must be trained to apply in the drawing-room, the shops and laboratories, the mathematics, chemistry and physics (espe-

cially mechanics and electricity) learned in the lecture- and class-rooms.

That is to say, there must be as complete a coordination of theory and practice as is possible in an institution of learning.

The tremendous activity in the industrial field creates a constant pressure for the inclusion in our course of closer specializations within our specialty. As our course is now so crowded that no additional work can be safely included without the elimination of an equal amount, this pressure, if not resisted, will almost surely result in the slighting of the essential fundamentals.

As in the past we have stood for the harmony of theory and practice and thoroughness, so we have stood for concentration on one broad course in mechanical engineering. While we have thus differentiated from the other broader divisions of the engineering profession, such as civil, mining and electrical, we have covered much that is included in these other divisions.

In any case we can not expect to graduate our men as engineers. As they get out in the world probably natural bent or necessity will lead most of them to further specialize. If so and they have taken advantage of the opportunities we have offered them and even forced upon them, they will find they are able to quickly and surely build upon the broad and strong foundations they have here laid.

There are certain studies which can not be properly or safely omitted from any engineering course, be it mechanical, civil, mining, electrical or any other. I should include in this list English, logic, history, modern languages, economics and business methods.

Outside of the question of culture, an engineer needs a working knowledge of his own language. He must be able to convey to his employers or associates in language concise and explicit the results of his work or investigations.

In the department of economics he should at least have sufficient insight into the science to guard himself against the danger of drawing conclusions from insufficient or inconsistent data.

He should have such a knowledge of business methods, and especially the principles of accounting, as to qualify him to exercise a close and independent supervision of manufacturing cost. He must appreciate the necessity for and be capable of instituting a system of charges, based upon a complete study of local conditions, to provide for the depreciation of plant and stock; he must appreciate the danger of confusing capital or investment items with revenue or expense items.

While we can not expect to give the engineer-student a working knowledge of the law of contracts, we should try to give him such instruction as will serve to warn him of the pitfalls to be avoided, and to impress him with the wisdom of seeking competent legal advice in all cases outside of established routine.

All this and more must be covered in a course which claims to harmonize theory and practice, for the engineer who is most practical in the shop may be most unpractical in business affairs—and here it is to be understood that the engineer must find his success within the limitations of commercial conditions.

Much of this part of the instruction may well be included in lectures on engineering practice, and preferably these lectures should be delivered by men who have themselves been successful as engineers and speak from that standpoint; for it is most difficult to impress upon students the necessity for the inclusion of these subjects in a course of engineering study. This applies particularly to the study of English, and every possible effort should be made to

quickly impress upon the freshman classes the reason why English is necessarily included in the curriculum; unless the sympathy of the students can be promptly secured in connection with this difficult study, there is but little hope that much good can be accomplished in the time available.

To do in four years all the work which has been here most briefly outlined the student should be strong mentally and physically and be possessed of a definite purpose.

There is danger of overstrain, but I firmly believe the danger of injury is less than in the case of the courses in some of our universities, where, according to our own observation, confirmed by the views lately expressed by a number of the university presidents, the students can take their B.A. degree in four years without any sustained effort. This is an enervating influence to which many young men can not safely be subjected. Our students are better able to sustain the strain to which we subject them because they average in years somewhat higher than those entering the universities for the first degree. Our last three classes averaged, respectively, at entrance, 18½ years, 18⅓ years and 18¾ years; a general average of say 18½ years.

This brings the average age of the graduate to more than 22½ years, as there are more of the younger students than the older who drop by the way.

This should dispose of the question of lengthening the course to five years, except in the case of the few who are specially qualified to carry on work in engineering research.

There can be no question that during the next decade we are to see many changes in our educational methods. We must here be prepared to listen to all suggestions with an open mind, and then be careful not to act rashly. During the last quarter century there have been in the United States not a few false moves made in our educational schemes, and especially has there been a tendency at times to spread out thin at the expense of thoroughness.

In looking over the list of our alumni and the work they have performed and are now performing, we can obtain therefrom enough encouragement to warrant us in moving slowly when radically different methods are suggested for our adoption.

When we think of these changes to come we may well hearten ourselves by recalling that many of our great universities and important colleges and separate technical schools are under the direction of men who are statesmen as well as scholars.

While it is our duty as teachers and guides to see to it first that the men entrusted to us should be producers and not dependents, that the problem of self-support should first be honestly and squarely met, we should further endeavor to cultivate in them aspirations for the higher things of this life and the life to come.

The motive for the struggle for success may at first be largely selfish, but, as we all can acknowledge with gratitude, from lower motives can be evolved those of a higher order.

While we of the faculty can not give our students religious training, we can be careful to set them an example of absolute honesty and straightforwardness. We can best eliminate meanness and trickiness from the student body by being ourselves candid, just and, as far as our natures will permit, sympathetic. We may well recall the names of the headmasters of certain schools whose influence upon the lives of their scholars has been potent to the end. It was not the curriculum or the system of teaching which made these schools so effective for good, but the personal influence of these men who were deeply sensible of the responsibility

of being entrusted with these young lives during the formative period.

Even in a school like ours the faculty can exert a strong personal influence for good and can, if they will, create an atmosphere of honesty which should be of special benefit to the students in connection with that vexed question of examinations. The responsibility for honest examinations first rests on the examiners. And we must remember that the man who is not honest in the class-room defrauds his *alma mater* and weakens and debauches his own character.

God grant that such an influence shall always be around the students of Stevens, and that so they may go out into the world not only honestly trained to take their places in the engineering profession, but also influenced to do their whole duty as citizens and self-respecting, God-fearing gentlemen.

ALEX. C. HUMPHREYS.

THE SOCIETY OF AMERICAN BACTERIOLOGISTS.

THE fourth annual meeting of the society was held at the Columbian University Medical School, Washington, D. C., on December 30, 31, 1902. Abstracts of papers* presented at the sessions of the society follow herewith:

Contribution to the Study of Agglutinins: W. W. FORD and J. T. HALSEY. (From the Pathological Laboratory, John Hopkins University.)

Experiments were undertaken to determine which constituent of the red blood corpuscle takes part in the production of lysins and agglutinins when the blood of one species of animal is used to immunize another species, Bordet stating that the stroma was responsible for the lysins, Nolf maintaining that the stroma was responsible for the agglutinins, the laked blood for the lysins. In the present experiments rabbits and guinea-pigs were immunized with the stroma and the laked blood of hens; guinea-pigs with the stroma and laked blood of rabbits; rabbits with the stroma, the laked blood, and the washings from the stroma, of the goose; and rabbits and guinea-pigs with the hæmoglobin of hens' and dogs' blood.

For the preparation of the stroma and the laked blood, the blood was washed with isotonic salt solution, laked with two to three times its bulk of water, made up to one per cent. salt solution, and centrifugalized to separate stroma from aqueous solution. Stroma was then washed repeatedly with water made up to one per cent. salt solution or with isotonic salt solution.

For the preparation of hæmoglobin the blood was collected in ammonium oxalate, washed, laked with distilled water, centrifugalized to get rid of the stroma, treated with 25 per cent. absolute alcohol, upon the addition of which the crystals of oxyhæmoglobin are deposited at 0° Centigrade. The dog's hæmoglobin crystallizes readily, the hen's hæmoglobin with some difficulty.

The results of the experiments showed that in all cases the animals immunized with the laked blood and the stroma from rabbits and from hens developed in their sera agglutinins and lysins both far beyond the limits of normal variation, so powerful that frequently in dilutions of 1–100, always in dilutions of 1–50, complete agglutination and lysis took place. The rabbits immunized with goose's blood stroma and aqueous solutions developed agglutinins only—no lysis taking place. The agglutinins were present in very high dilutions, at times 1–10,000, always in dilutions of 1–1,000. Normal rabbit's serum agglutinates goose's blood in dilutions of 1–250 or 1–330. The attempt to supply a complement for a hypothetical amboceptor

* The abstracts were prepared by the authors.